CODEN [USA]: IAJPBB ISSN: 2349-7750

INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES

http://doi.org/10.5281/zenodo.2389051

Available online at: http://www.iajps.com *Research Article*

INSTRUMENTS & ADVANCES IN ENDODONTICS

Amal Mohammed alanaze[1] , Ahmed Radhi a almakinah[1], Mona emad mitwalli [2] , Hydar Mohammed Alnowaisser[3] , Mohammed Mutlaq ALNawmasi[3] , mousa hamdan alsagri[3] , Rayed Mayah Alshammari [3] , Fahad AL-Nashmy AL-Shammri[3] , Alwaleed bin talal alanazi[3] , Mujtaba mansour alnowaisser[3]

[1]Alfarabi Colleges for Dentistry and Nursing, [2] Battarji Medical College, [3] Minstry of health

Abstract

Background: *Endodontics is the dental specialty concerned with the prevention and treatment of pulpal and peri-radicular diseases. Endodontics requires the use of several instruments to treat pulpal and peri-radicular diseases.*

The aim of work: *This study aims to understand the recent advances of endodontic instruments for better for efficient root canal treatment.*

Materials and methods: *This review is using the comprehensive search of PUBMED, Journal of Endodontics, J American Dental Association from 1971 to 2017. The following search terms were used: extirpating instruments, hand-driven instruments, Pro-file, ProTaper, LASERS, Flex Master*

Conclusion: *Root canal treatment is the procedure which involves various steps starting from accessing the encapsulated pulpal tissues and eventually preparing and disinfecting the accessed space and canals. The aim of root canal treatment is to create a sterile space that retains a sealing as well as filling material to prevent further infection and reinfection. Thus, proper instrumentation has proven to be an essential tool in dentistry when used efficaciously and ethically.*

Keywords: *Extirpating Instruments, Hand-Driven Instruments, Pro-File, Protaper, Lasers, Flex Master*

Corresponding author:

Amal Mohammed alanaze,

Alfarabi Colleges for Dentistry and Nursing,

Email: amal-6677@hotmail. Com,

Mobile: +96655060894.

QR code

Please cite this article in press Amal Mohammed alanaze et al., ***Instruments & Advances In Endodontics.,*** *Indo Am. J. P. Sci, 2018; 05(12).*

INTRODUCTION:

Endodontics is the dental specialty concerned with the prevention and treatment of pulpal and peri-radicular diseases. The pulpal and peri-radicular disease affect the periodontium which includes the tissue encapsulated within the hard-dental tissues as well the tissues surrounding the roots; the periodontal ligament and alveolar bone. Root canal treatment is the procedure which prevents the extraction of the tooth, and moreover, it maintains the functionality of the tooth. Root canal treatment is the procedure which involves various steps starting from accessing the encapsulated pulpal tissues and eventually preparing and disinfecting the accessed space and canals. The aim of root canal treatment is to create a sterile space that retains a sealing as well as filling material to prevent further infection and reinfection.

METHODOLOGY:

- **Data Sources and Search terms**

We conducted this review using a comprehensive search of MEDLINE, PubMed and EMBASE, , Journal of Endodontics, J American Dental Association from 1971 to 2017. The following search terms were used: extirpating instruments, hand-driven instruments, Pro-file, ProTaper, LASERS, Flex Master

- **Data Extraction**

Two reviewers have independently reviewed the studies, abstracted data and disagreements were resolved by consensus. Studies were evaluated for quality and a review protocol was followed throughout.

This study was done after approval of ethical board of King Abdulaziz University.

BRIEF HISTORY:

1875 was the year which dates to the first use and manufacture of first endodontic instrument. During these early times there was more emphasis on to the obturation than to cleaning of the root canal system due to lack of sophistication.

In 1932 G.V. Skillen quantified that curettage of canal wall is necessary to remove the pulp debris because he believed that residual tissue which were left behind could be degenerative and might lead to failure of the treatment. Grove was the first one who designed “standardized instruments and gold cones”. Jasper introduced silver cones as obturating material to the dentistry [1].

Ingle in 1955 expressed the need for standardisation of endodontic instruments which he advocated at Second International Conference of Endodontics which was held in the year 1958. In 1961, Ingle created a standardized basic shape for endodontic instruments in which he substituted stainless steel for carbon steel and also color coded them, which was accepted by AAE in the year 1965. Specification #28 was designated for the endodontic instruments in 1976 by the Council of Dental Materials and Devices of American Dental Association. The system of standardization and agreements among the various manufacturers to observe them is therefore a fairly recent development [1,2].

CLASSIFICATION:

Various taxonomies have been proposed for endodontic instruments but the easiest would be to classify them according to the sequence of usage during RCT procedure [3]:

I- Diagnostic instruments

II- Extirpating instruments

III- Enlarging instruments

IV- Miscellaneous

An endodontic instrument pack.

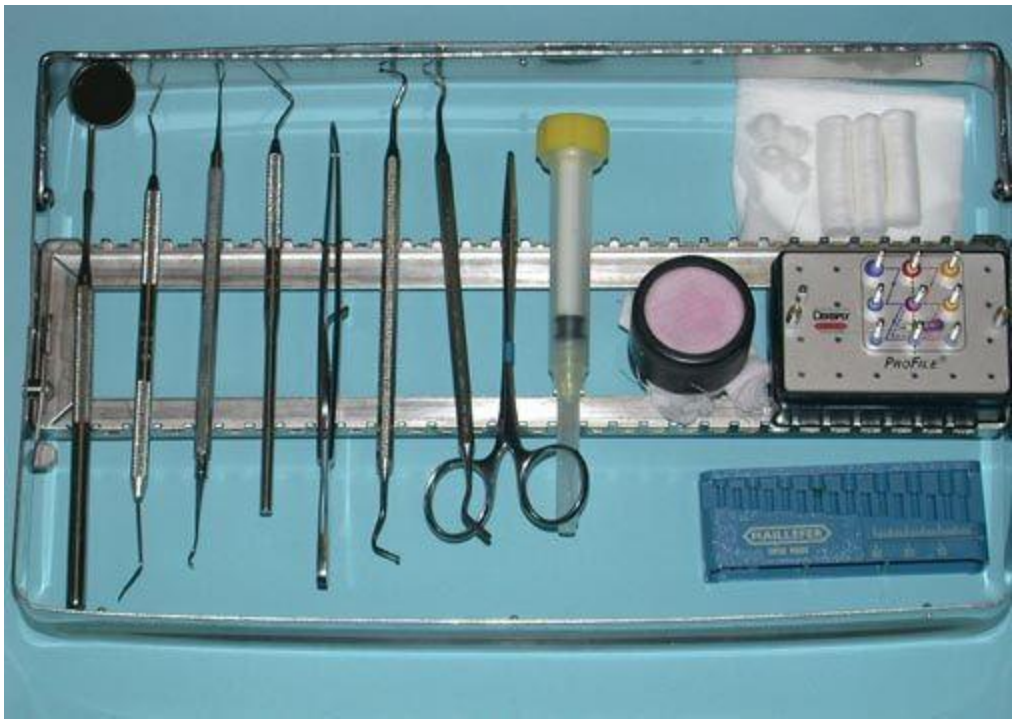

FIGURE 1: From left to right; front surface reflecting mirror; DG16 endodontic probe; Western probe; CPITN probe; endo-locking tweezers; long shank excavator; flat plastic, artery forceps, endodontic syringe; plus, clean stand, file stand, measuring device, sterile cotton wool rolls and pledgets [16]

DIAGNOSTIC INSTRUMENTS:

Basic diagnostic instruments include mirror, explorer and tweezer; however, a number of specialized devices are necessary in addition to these basic instruments for more accurate diagnosis [3].

1. Visual aids:

Recently, magnifying elements have been incorporated in the endodontic practice to enhance vision in the operative site. These magnifying elements could be as simple as magnifying loupes to highly sophisticated dental operating microscopes [3].

2. Vitality testing:

Chairside assessment of pulp vitality is of utmost importance in reaching proper diagnosis. Pulp vitality testing is done either by stimulating the neural element or by measuring the vascular conductance [3].

Neural Tests:

This is the most popular chairside method deployed to check the vitality of the pulp, more specifically it is called as pulp sensibility testing, it is done through thermal or electrical stimulation of the peripheral nerve endings.

Thermal testing: This includes a group of testing agents either hot or cold.

Cold testing: Ice ---------- 0° C

Ethyl chloride ---------- -7° C

CO_2 snow ---------- -78° C

Hot testing: Rubber wheel

Hot instruments

Gutta percha stopping

Electrical Testing: Electrical testing includes a group of devices that deliver a very low electrical current to the enamel surface in the presence of an electrolyte and commonly these devices are called as Electrical Pulp tester(EPT) [3].

Vascular Tests:

The testing of vascular element truly reflects the vitality of the pulp rather than it's neural supply. Vascular testing includes Laser doppler flowmetry and Pulse oximetry [3].

Radiographs:
Radiograph is the most essential tool during all phases of root canal therapy, as the time passed different radiographic devices were introduced in addition to Plain radiography, which includes Xeroradiography - CT-Scan - Radiovisiography (RVG) [3].

Extirpating instruments
Barbed (nerve) Broaches: extirpation of intact pulp tissue is done using barbed broaches, it is slowly introduced into the canal and then rotated full turn to entangle the pulpal tissue and then withdrawn. Barbed broaches have a wea design due to which it's usage is limited maximum to 3 in larger canals whereas in narrow canals any enlarging instrument such as H-file can be used for extirpation [4].

Enlarging instruments
Biomechanical preparation of the root canal is achieved either by hand driven instruments or combination of hand driven and engine driven instruments [4].

Hand-driven enlarging instruments

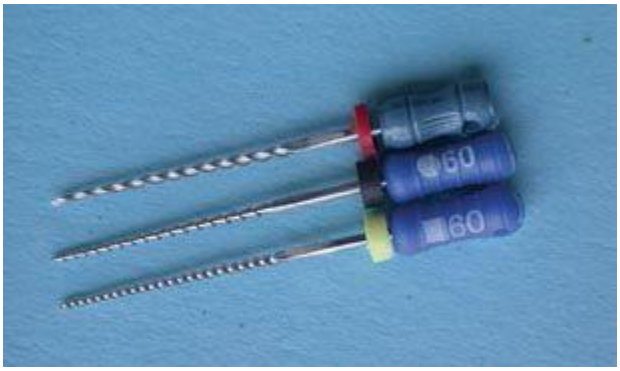

FIGURE 2: Conventional hand instruments; top – reamer with red stop; middle - Hedstroem file with black stop; bottom - K-flex file with yellow stop [16]

A- Basic enlarging instruments
These are the most commonly used instruments and basically consists of four types of instruments, which are [5]:

(i) K-file

K-file is fabricated using round stainless-steel blank which is cut to form a tapered instrument thus achieving pointed tip with square cross-section. Spirals (flutes) are formed onto this wire by twisting it in counter-clockwise direction achieving 1.5-2.5 flute/mm. K-files are used either in filing action or reaming action. It shows two types of failures which are ductile type fracture or "Sudden" brittle type fracture.

(ii) K-reamer

The fabrication of K-file and K-reamer is almost similar except K-reamer is having triangular cross section with lesser number of flutes (0.5-1 flute/mm)

(iii) H-file (Hedstrom file)

H-file is also fabricated using round stainless-steel wire by machine grinding forming a series of intersecting cones which produces sharp edges at the base of each cone. H-file cuts the tooth structure by pulling only and reaming motion should be avoided as it may lead to the fracture of the instrument due to weak shaft.

(iv) R-file (Rat-tail file)

R-file is very similar to barbed broach in design as it has metal projections which are perpendicular to the instrument shaft with an eight pointed polyhedron cross section [5].

B- Hybrid enlarging instruments
None of the instrument till date can effeciently debride the entire root canal space while maintaining it's original anatomy. Thus, to fulfil the goal of maintaining original shape of the canal space there has been continous development and improvement in the design and physical properties of the endodontic

instruments [6].

Modifications include: A.Modification in instrument design.
B.Modification in method of manufacturing.

C.Modification in instrument material

A. Modification in instrument design.

(i) Modification in instrument cross-section [6]:

- Flex-R-file: These files are manufactured by modifying the square cross section of K-file to triangular cross section. It has several advantages over K-file Which includes increase in cutting ability, Increase of carrier effect and more flexibility.
- K-flex file: K-flex file are manufactured by modifying square cross section of K-file to rhomboid cross section. It has 2 acute angles and 2 obtuse angles which increases sharpness and more space for debris removal respectively And Moreover it has increased flexibility.
- S-file / Uni-file: It is manufactured by adding second blade(S-file & Uni-file) or by adding third blade(Helifile) to the conventional single blade H-file Which significantly increases the cutting ability of the tool.
- U-file: The U-file was 1st introduced in 1988.The 3 points of the blade has two 90 degree cutting edges. It possesses radial lands Which is a flat cutting surface and act as a planning instrument. This land allows the instrument to be used in 360° motion.

(ii) Modification in length of cutting blade [7]:

- *Canal master file:*

It was introduced in 1989 by Senia and Wiley Invention the cutting segment of the instrument was reduced to 1-3 mm from 16 mm. According to the developers this modification led to the reduction in the chance of canal transportation and ledging during enlargement of the curved canals.

- *Profile Great taper system (GT):*

It is a router instrument which has a cutting blade of 6-8mm instead of 16 mm

- *Light speed system:*

It is a Rotary system with the cutting blade of length from 0.25 mm to 1.75 mm.

(iii) Modification in taper Instruments:
With the recent advancements the standard taper of 0.02 mm has been replaced either by 0.04, 0.06- or 0.08-mm taper [7].

(iv) Modification in tip design:
Nowadays the instruments which are produced have noncutting tip which have shown to decrease the chances for denial transportation and ledging during enlarging curved canals, the eg of which can be Flex-R file [7].

(v) Modification in numbering system:
Golden mediums: These are instrument sets with intermediate sizes (12.5, 17.5, 22.5, 27.5, 32.5, ….).

Profile Series 29:

Profile series 29 was introduced by Schilder in 1992. In This system instrument size progress is by a constant percentage increase of 29%, it is available in sizes 00,0,1 till 11. The advantages of this system are that it provides constant increase in instrument diameter and also provides fewer number of instruments [7].

B. Modification in method of manufacturing
Instead of instrument twisting, the flutes were created by grinding or milling to decrease the internal stresses induced inside the instrument during the twisting proces, the first example of which was Flex-R file [8].

C. Modification in instrument material
The first basic instruments were Manufactured from carbon steel but later it was replaced by stainless steel due to less flexibility and low corrosion resistance of carbon steel. Stainless steel had reasonable flexibility but in the cases of curved canals its usage was limited, this led to the development of super elastic material called Nickel-Titanium alloy which offered better flexibility [9].

(2) Engine-driven enlarging instruments
With time the popularity of rotary or engine driven instruments is gaining popularity due to increased speed and effeciency. These instruments can be classified according to their type of motion [10]:

A- Devices utilizing vibratory motion (sonics and ultrasonics)

B- Devices utilizing rotary motion (low speed contra-angle)

A- Vibratory instruments

These instruments work on vibratory action and they are divided in two categories based on the frequency: Sonics (less than 20KHz) and Ultrasonic (20-50KHz)

The debriding mechanism of sonics/ultrasonics was thought to be by 'Cavitation', but it is believed now that a different phenomenon called as 'Acoustic Streaming' is responsible for its debriding action [10].

B- Rotary instruments:

Figure 3: A low-speed, high-torque motor required for use with nickel-titanium rotary instruments [16]

The rotary system is made up of two parts : One part consists of low speed contra-angled handpiece which is again of 3 types : a full rotary hand piece, a reciprocating quarter turn hand piece and a reciprocating hand piece with vertical stroke; while the Second part is the enlarging tool.

Ni-Ti alloy revolutionised the dentistry and led to the development of new rotary enlarging instruments. These new systems include [7]:

1. Profile and Profile GT systems.

2. Light speed system.

3. Quantec system.

4. Pow-R system.

5. Protaper system

6. Hero 642 system.

1. Profile and Profile GT systems.

In 1889, William H. Rollins developed the first endodontic hand piece for automated root canal preparation and used specially designed needles with a 360-degree rotation and 100 Revolutions Per Minute (RPM) limited speed to avoid instrument [11].

ProFile system consists of Orifice shapers, different taper Profile system, Greater taper system, Series 29 and ProTaper system.

ProFile Series 29

Manufactured by Tulsa Dental and feature a constant increase of 29% in diameter of successive file size, it offers smooth, progressive preparation of canal [11].

PROFILE:

It is available in a taper of, 2%. 4% and 6%. These rotary instruments have a cutting length of 16 mm with safe non-cutting tip. 2% taper files are designed for extremely curved canals, whereas 4% taper files were initially designed for subsequent carrier based obturation method and 6% taper files provide fuller shape over the length of pulp space [11].

Pro System® GT® or Greater Taper (GT) rotary files

This system consists of for instruments with non-cutting tip and are variably pitched with fixed minimal and maximal flute diameters. The D0 diameter is fixed at 0.20, 0.30, or 0.40mm while maximum flute diameter of 1.0 mm. It is supplied in the taper of 0.10, 0.08, 0.06 and 0.04.

Accessory GT® files

This system comes in a set of 3 instruments with a taper of 0.12. These files have maximal diameter of 1.5mm whereas maximal D0 diameter is of 0.90 mm [11,12].

The Quantec™ system

Was developed by McSpadden and was introduced in the market in 1966 by Sybron Endo. These files are available in a variety of taper: 0.12, 0.10, 0.08, 0.06, 0.05, 0.04, 0.03 and 0.02. every file in quantec system has a fixed D0 diameter of 0.25 mm. Quantec files exhibits a variable taper and are also available in either non-cutting (LX) or safe-cutting (SC) tip. Recommended speed for these instruments by manufacturer is 340 RPM [11].

HERO 642® (Micro Mega, France)

This system works in a continuous rotary motion at a speed of 300-600 rpm and is available in a taper of 2%, 4% and 6%. Blue sequence has to be followed when shaping canals with straight curves (<5°). The rubber stop present in the file is adjusted to ½-2/3 of

the determined W.L. and then the file is penetrated into the canal while it is rotating [12].

FlexMaster®

The cutting blades of this sytem are inspired from traditional K-type cutting blades. The advantages of K-type cutting blades is that it has 1. High cutting efficiency 2. Improved torsional resistance 3. Reduced friction 4. Large space for dentin removal 5. Reduced smear layer formation. FlexMaster system is available in 2%, 4%, 6% and 11% taper. Introfile has 11% taper and is used for enlargement of canal orifice, whereas 4% and 6% files are used for cleaning and shaping in a crow down manner [13].

RaCe™

RaCe stands for Reamer with Alternating Cutting Edges, it is an innovative system which provides safety and easiness in cleaning and shaping of root canals. Eg. – FKG RaCe system

RaCe system uses a combination of triangular cross section and alternating cutting edges which ensures efficient removal of debris. The race system comes with a taper of 2%, 4%, 6%, 8% or 10% [13].

Protaper® file

Protaper file system has a patented technology of advanced flute design and progressive taper which provides better flexibility and more efficiency to achieve consistent and successful preparation. This system includes various files

Sx,S1,S2 = shaping files for coronal and middle third.

F1,F2,F3,F4 and F5 = for finishing of apical 3rd as per required demand [12,13].

IV- MISCELLANEOUS:

LASERS:

Laser technology was introduced to endodontics with the goal of improving the results obtained from traditional procedures by increasing cleaning ability and the removal of debris and the smear layer from the root canals and also improving the decontamination of the endodontic system [14].
Lasers wavelength considerations:

Eradication of micro-organisms from the root canal space especially from the lateral canals is the primary use of lasers in endodontics, for which it should have required wavelength so that it can transmit through hydroxyapatite and water. Choice of lasers as per their preference is as follows [11,15]:

- Nd: YAG lasers
- Diode laser
- Er: YAG; Er, Cr: YSGG and CO2 lasers

Applications [17]:

1. Nd: YAG for analgesia
2. He-Neon laser for pulp vitality testing
3. Pulsed Nd: YAG for pulp capping
4. In Root Canal Treatment

- Access cavity preparation and orifice enlargement
- In the preparation of root canals
- Disinfection
- Removal of pulp remnants and debris
- As an aid in obturation with gutta percha
- Removal of restorative material and cements from the cavity

Er:YAG and Er, Cr:YSGG lasers are used for access cavity preparation and bio-mechanical preparation of the root canals. Nd:YAG is used for disinfection by 'Photoactivation'. In Photoactivated disinfection, tolonium dye is applied to the infected area and light is transmitted into the root canals at the tip of a small flexible optical fiber that is attached to a disposable handpiece [17,18].

5. Laser Treatment Of Periapical Lesions Of Sinus Tract: Pulsed Nd:YAG and CO_2 lasers are the lasers of choice where surgical endodontics cannot be performed.

6. Lasers in surgical endodontics: Nd:YAG and Er:YAG lasers are used [17].

CONCLUSION:

Combined evaluation of the parameters required in endodontics leads to the choice of specific system required in that very scenario. There is no absolute best design or superior file it all depends on the working conditions such as type and position of the tooth, number of canals and type of pulp canal space. We should understand the limitations and potential complications of the endodontic system that are available today. The progressive nature of the taper does seem to put the file at greater risk for separation. LASERS with time has proven to be an essential tool in dentistry when used efficaciously and ethically. With the development of thinner, more flexible and durable laser fibers, laser applications in endodontics will increase. With the advancement in technology the ability to care for patients has drastically improved.

REFERENCES:

1. **European Society of Endodontology (2006)**: Quality guidelines for endodontic treatment:

consensus report of the European Society of Endodontology. Int Endod J., 39:921–930.
2. **Nanci A (2013)**: Ten Cate's oral histology: development, structure, and function, pp. 70–94. St Louis, MO: Elsevier.
3. **Peters OA, Peters CI and Basrani B (2015):** Cleaning and shaping the root canal system. In Pathways of the pulp (eds MH Hargreaves, LH Berman, S Cohen), pp. 209–279. St Louis, MO: Elsevier.
4. **P Carrote (2004)**: Basic Instruments and Materials for Root Canal Treatment. Vol 197, pp. 8
5. **Mitchell M (2011)**: *Dental instruments: A pocket guide to identification*. Lippincott Williams & Wilkins.
6. **Walton RE, Torabinejad M (2002)**: Principles and practice of endodontics. 3rd Edition. Saunders Company, pp. 222.
7. **Walia H, Brantley WA and Gerstein H (1988):** An initial investigation of the bending and torsional properties of Nitinol root canal files. Journal of Endodontics, 14:346-51.
8. **Kim HC, Kim HJ, Lee CJ, Kim BM, Park JK and Versluis A (2009)**: Mechanical response of nickel– titanium instruments with different cross-sectional designs during shaping of simulated curved canals. International Endodontic Journal, 42:593-602.
9. **Milas VB, History, Cohen R and Burns R (1987):** Pathways of the Pulp, 4th edition, ST Louis, MO: C,V, Mosb,: 619-34.
10. **Hülsmann M, Peters OA and Dummer PM (2005):** Mechanical preparation of root canals: shaping goals, techniques and means. Endodontic Topics, 10:30-76.
11. **Bansode PV (2017)**: C-Shaped Root Canal Anatomy: A Literature Review. International j of Medical Science and Intervention, 4:2538-2543
12. **Peters OA, Paqué F (2010)**: Current developments in rotary root canal instrument technology and clinical use: a review. Quintessence International, 41(6).
13. **Revathi M, Rao CV and Lakshminarayanan L (2001):** Revolution in endodontic instruments-A review. Endodontology, 13:43-50.
14. **Giovanni Olivi, Rolando Crippa, Giuseppe Iaria, VasiliosKaitsas, Enrico DiVito and Stefano Benedicenti (2011)**: Lasers in Endodontics (Part I). Roots, pp. 1-4.
15. **Karlovic Z, Pezelj-Ribaric S, Miletic I, Jukic S, Grgurevic J and Anic I(2005)**: Erbium:YAG laser versus ultrasonic in preparation of root-end cavities. J Endod., 31:821–3.
16. **Carrotte P (2004):** Endodontics: Part 5 Basic instruments and materials for root canal treatment. British Dental Journal, 197:455.
17. **Adrian JC, Bernier JL and Sprague WG (1971)**: Laser and the dental pulp. J Am Dent Assoc., 83:113-7.
18. **Yamamoto H, Sato K (1980):** Prevention of dental caries by acoustooptically Q-switched Nd:YAG laser irradiation. J Dent Res., 59:137.